Information about GB Non-native Species Risk Assessments

The Convention on Biological Diversity (CBD) emphasises the need for a precautionary approach towards non-native species where there is often a lack of firm scientific evidence. It also strongly promotes the use of good quality risk assessment to help underpin this approach. The GB risk analysis mechanism has been developed to help facilitate such an approach in Great Britain. It complies with the CBD and reflects standards used by other schemes such as the Intergovernmental Panel on Climate Change, European Plant Protection Organisation and European Food Safety Authority to ensure good practice.

Risk assessments, along with other information, are used to help support decision making in Great Britain. They do not in themselves determine government policy.

The Non-native Species Secretariat (NNSS) manages the risk analysis process on behalf of the GB Programme Board for Non-native Species. Risk assessments are carried out by independent experts from a range of organisations. As part of the risk analysis process risk assessments are:

- Completed using a consistent risk assessment template to ensure that the full range of issues recognised in international standards are addressed.
- Drafted by an independent expert on the species and peer reviewed by a different expert.
- Approved by an independent risk analysis panel (known as the Non-native Species Risk Analysis Panel or NNRAP) only when they are satisfied the assessment is fit-for-purpose.
- Approved for publication by the GB Programme Board for Non-native Species.
- Placed on the GB Non-native Species Secretariat (NNSS) website for a three month period of public comment.
- Finalised by the risk assessor to the satisfaction of the NNRAP.

To find out more about the risk analysis mechanism go to: www.nonnativespecies.org

Common misconceptions about risk assessments

To address a number of common misconceptions about non-native species risk assessments, the following points should be noted:

- Risk assessments consider only the risks posed by a species. They do not consider the practicalities, impacts or other issues relating to the management of the species. They therefore cannot on their own be used to determine what, if any, management response should be undertaken.
- Risk assessments are about negative impacts and are not meant to consider positive impacts that may also occur. The positive impacts would be considered as part of an overall policy decision.
- Risk assessments are advisory and therefore part of the suite of information on which policy decisions are based.
- Completed risk assessments are not final and absolute. Substantive new scientific evidence may prompt a re-evaluation of the risks and/or a change of policy.

Period for comment

Draft risk assessments are available for a period of three months from the date of posting on the NNSS website*. During this time stakeholders are invited to comment on the scientific evidence which underpins the assessments or provide information on other relevant evidence or research that may be available. Relevant comments are collated by the NNSS and sent to the risk assessor. The assessor reviews the comments and, if necessary, amends the risk assessment. The final risk assessment is then checked and approved by the NNRAP.

*risk assessments are posted online at:
https://secure.fera.defra.gov.uk/nonnativespecies/index.cfm?sectionid=51
comments should be emailed to nnss@fera.gsi.gov.uk

GB NON-NATIVE ORGANISM RISK ASSESSMENT SCHEME

For more information visit: www.nonnativespecies.org

	Name of Organism:	***Procyon lotor* - Raccoon**
	Objectives:	Assess the risks associated with this species in GB
	Version:	Original draft 22/02/11
	Author:	A. Zalewski (Centre of Excellence in Biodiversity Conservation and Mammal Research (BIOTER) - Poland)
	Suggested citation:	Zalewski (2011). GB Non-native Organism Risk Assessment for *Procyon lotor* . www.nonnativespecies.org

N	QUESTION	RESPONSE	COMMENT
1	What is the reason for performing the Risk		Request by the GB Programme Board
2	What is the Risk Assessment area?	GB	
3	Does a relevant earlier Risk Assessment exist?	NO OR UNKNOWN (Go to 5)	
4	If there is an earlier Risk Assessment is it still entirely valid, or only partly valid?		
A	**Stage 2: Organism Risk Assessment SECTION A: Organism Screening**		
5	Identify the Organism. Is the organism clearly a single taxonomic entity and can it be adequately distinguished from other entities of the same rank?	YES (Give the full name & Go to 7)	Procyon lotor (Linnaeus, 1758) Raccoon - Procyonidae - Carnivora - Mammal - Animal Procyon lotor (Linnaeus, 1758) Raccoon - Procyonidae - Carnivora - Mammal - Animal. In North America, a large number (25) of subspecies is recognized (Zeveloff 2002). The number of subspecies introduced around the world and kept as pets is unknown, therefore detailed taxonomic status of potential invasive animals is likely to be unknown.
6	If not a single taxonomic entity, can it be redefined?		
7	Is the organism in its present range known to be invasive, i.e. to threaten species, habitats or ecosystems?	YES (Go to 9)	The Raccoon is one of the most chronic nuisance animals in North America (Zeveloff 2002). It is a predator of eggs, chicks and adult birds, especially waterfowl (Hartman et al. 1999, Zeveloff 2002). Although their impact on bird populations varies, raccoons can have a severe effect on them in certain circumstances (e.g. on coastal islands or in large seabird colonies) (Hartman et al. 1997, Hartman and Eastman 1999). Raccoons can predate a large proportion of sea turtle nests in the United States (see Ratnaswamy et al. 1997, Ratnaswamy et al. 1998). They can kill domesticated animals, e.g. poultry (Zeveloff 2002); transmit diseases and parasites to domestic and wildlife species and humans (raccoons have been identified as the major wildlife host of rabies in the United States); can cause damage to fields and garden crops (e.g. corn)(Conovery 1987, Beasley et al. 2008); and cause damage or nuisance problems around houses. In their introduced range (Japan), it was suggested that raccoons have a negative impact on native endangered species like Tokyo salamanders, Asian clam or some species of crabs (Hayama et al. 2006). A negative impact on native competitors is also possible. In Japan, abundance of native raccoon dogs decreased after the invasion of raccoon (Ikeda et al. 2004). On the other hand, there are no studies analysing the raccoon's impact on birds and mammals in Europe yet it is expected to be significant, especially on birds (e.g. waterfowl).
8	Does the organism have intrinsic attributes that indicate that it could be invasive, i.e. threaten species, habitats or ecosystems?		
9	Does the organism occur outside effective containment in the Risk Assessment area?	NO (Go to 11)	The Raccoon was observed in the wild in the Risk Assessment Area. For example, 34 individuals have been recorded out of captivity in England and Wales on 32 occasions between January 1970 and May 2006 (Baker 1990, Harris and Yalden 2008). There is no evidence of an established breeding population (Harris and Yalden 2008), however the number of raccoon observations out of captivity steadily accumulates (one was observed as recently as March 2009 - S Baker, pers. com.). The reason why they did not naturalize in the Risk Assessment Area is probably the fact that, due to low and spatially distributed numbers, the escaped animals are still not able to mate (Baker 1990).
10	Is the organism widely distributed in the Risk Assessment area?		

11	Does at least one species (for herbivores, predators and parasites) or suitable habitat vital for the survival, development and multiplication of the organism occur in the Risk Assessment area, in the open, in protected conditions or both?	YES (Go to 12)	Individual raccoons have survived out of captivity within the Risk Assessment Area for up to 4 years (Harris and Yalden 2008).
12	Does the organism require another species for critical stages in its life cycle such as growth (e.g. root symbionts), reproduction (e.g. pollinators; egg incubators), spread (e.g. seed dispersers) and transmission, (e.g. vectors)?	NO (Go to 14)	
13	Is the other critical species identified in question 12 (or a similar species that may provide a similar function) present in the Risk Assessment area or likely to be introduced? If in doubt, then a separate assessment of the probability of introduction of this species may be needed		
14	Does the known geographical distribution of the organism include ecoclimatic zones comparable with those of the Risk Assessment area or sufficiently similar for the organism to survive and thrive?	YES (Go to 16)	The raccoon ranges across the North American continent, but has also invaded Japan and a large part of Europe (Germany, Poland, France, Luxembourg, Netherlands, Belgium, Switzerland, Austria, Hungary, Yugoslavia, Belarus) which has an ecoclimatic zone similar to the Risk Assessment Area.
15	Could the organism establish under protected conditions (e.g. glasshouses, aquaculture facilities, terraria, zoological gardens) in the Risk Assessment area?		
16	Has the organism entered and established viable (reproducing) populations in new areas outside its original range, either as a direct or indirect result of man's activities?	YES (Go to 17)	The raccoon was deliberately introduced to Germany about 80 years ago. After introduction, its geographical range increased through natural expansion, most rapidly in the last 20 years. In Europe, the raccoon is now distributed through Germany and parts of Poland, France, Luxembourg, the Netherlands, Belgium, Switzerland, Austria, Hungary, the Czech Republic and the former Yugoslavia (Mitchell-Jones et al. 1999, Červeny et al. 2001, Schley et al. 2001, Milenkovic 2003). In Germany, from a small number of individuals in 1930-1940, the population has increased to between 100,000 and one million raccoons (except that 20,000 raccoons were shot in the 2004/2005 season). There is a lack of information about current population size in Europe.
17	Can the organism spread rapidly by natural means or by human assistance?	YES (Go to 18)	Raccoons can escape from collections open to the public and from private individuals who keep raccoons as pets etc. , but there is a low probability of a raccoon being transported from Europe.
18	Could the organism as such, or acting as a vector, cause economic, environmental or social harm in the Risk Assessment area?	YES OR UNCERTAIN (Go to 19)	Potentially significant impact as a predator on seabirds and waterfowl. Parasite transmission, especially roundworm *Baylisascaris procyonis* , which is a cause of severe human disease (Sorvillo et al. 2002, Bartoszewicz et al. 2008). More than 90 species of wild and domestic animals have been identified as being infected with this roundworm which may cause, for example, a fatal central nervous system disease in commercial chickens, pheasants and rabbits. Natural infections have been recognized in dogs, rodents, foxes and weasels. Raccoon may cause environmental harm by predation on native, endangered species (Hayama et al. 2006). However, there was no evidence of negative impact on native prey or competitors in Germany (Lutz 1981, Horstmann and Schmincke 2004). Raccoons caused damage to buildings and houses (especially roofs and attics where they look for resting sites). They also damaged garden crops (e.g. fruit trees) (Hohmann et al. 2002).
19	This organism could present a risk to the Risk Assessment area and a detailed risk assessment is appropriate.	Detailed Risk Assessment Appropriate GO TO SECTION B	
20	This organism is not likely to be a harmful non-native organism in the Risk Assessment area and the assessment can stop.		

B	SECTION B: Detailed assessment of an organism's probability of entry, establishment and spread and the magnitude of the economic, environmental and social consequences			
	Probability of Entry	**RESPONSE**	**UNCERTAINTY**	**COMMENT**
1.1	List the pathways that the organism could be carried on. How many relevant pathways can the organism be carried on?	few - 1	MEDIUM -1	Escapes of raccoons kept privately as pets and from collections open to the public are the most likely pathways. Transport from Europe is possible but a low probability. In the larger part of the Risk Assessment Area, fur farms are not an important source of raccoons, as breeding of mammals for fur is illegal in England, Wales and Scotland, following the Fur Farming (Prohibition) Act 2000 and the Fur Farming (Prohibition)(Scotland) Act 2002. Ireland did not prohibit fur farming, therefore animals could disperse from that direction. However, Ireland farms mainly mink and fox.
1.2	Choose one pathway from the list of pathways selected in 1.1 to begin the pathway assessments.	Escepees/release of pets or from zoos and wildlife parks.		In 2000, approximately 30-40 raccoons were kept by private owners in UK (Greenwood et al. 2001). Since 2007, raccoon was removed from the Schedule (Dangerous Wild Animals Act 1976) and does not require a licence. This may increase the ownership and subsequent abandonment of raccoons and therefore it is now very difficult to estimate the number of animals kept in the UK. Records of free-living raccoons in the UK are relatively common (13 between 2000-2007; Parrott et al. 2008) suggesting relatively large numbers of raccoons kept by private owners.
1.3	How likely is the organism to be associated with the pathway at origin?	moderately likely - 2	LOW - 0	Species present in central Europe at high density. Still commonly bred in captivity in the Risk Assessment Area, mainly by private owners, for the pet trade and wildlife collections (e.g.: The Independent, 28 September 2007, 'The Seafords even breed raccoons but they are mainly to delight children visiting the farm.' [Wiltshire]). There was a significant increase in raccoons found out of captivity in England and Wales following a change to the Dangerous Wild Animals Act (in 1984) to which they then became subject, leading to licensing costs and a requirement for higher keeping standards (Baker S. 1990). This indicates that pet raccoons could be deliberately released into the wild under certain circumstances.
1.4	Is the concentration of the organism on the pathway at origin likely to be high?	moderately likely - 2	LOW - 0	Somewhere between 100,000 and one million raccoons are estimated to live in Germany.
1.5	How likely is the organism to survive existing cultivation or commercial practices?	very likely - 4	LOW - 0	Does very well in Central Europe.
1.6	How likely is the organism to survive or remain undetected by existing measures?	unlikely - 1	LOW - 0	Escaped raccoons are sometimes difficult to detect. Some of them may have survived for as much as 3-4 years (Corbert and Harris 1996).
1.7	How likely is the organism to survive during transport /storage?	moderately likely - 2	LOW - 0	Survival very high if it is imported to breeding centres and zoos. Small probability of unintentional transport.
1.8	How likely is the organism to multiply/increase in prevalence during transport /storage?	N/A		
1.9	What is the volume of movement along the pathway?	minimal - 0	LOW - 0	
1.10	How frequent is movement along the pathway?	occasionally - 2	MEDIUM -1	
1.11	How widely could the organism be distributed throughout the Risk Assessment area?	very widely - 4	MEDIUM -1	Density in urban and rural areas reaches 100 ind. per 100 ha; in wetlands 2 ind. per 100 ha. (Michler and Hohmann 2005, Bartoszewicz et al. 2008).
1.12	How likely is the organism to arrive during the months of the year most appropriate for establishment ?	very likely - 4	LOW - 0	There is evidence that escapees survive up to 4 years out of captivity within the Risk Assessment Area (Harris and Yalden 2008) which, coupled with their survival in similar climatic areas in Europe, makes it highly likely that the species could survive if introduced at any time of year.
1.13	How likely is the intended use of the commodity (e.g. processing, consumption, planting, disposal of waste, by-products) or other material with which the organism is associated to aid transfer to a suitable habitat?	N/A		
1.14	How likely is the organism to be able to transfer from the pathway to a suitable habitat?	very likely - 4	LOW - 0	Raccoons are bred in the countryside - individuals can move there very quickly to suitable habitat for foraging and resting. Dense human population in the Risk Assessment Area increases the probability of survival in the wild.

	Probability of Establishment	RESPONSE	UNCERTAINTY	COMMENT
1.15	How similar are the climatic conditions that would affect establishment in the Risk Assessment area and in the area of current distribution?	very similar - 4	LOW - 0	Central Europe has an ecoclimate zone similar to the Risk Assessment Area.
1.16	How similar are other abiotic factors that would affect establishment in the Risk Assessment area and in the area of present distribution?	very similar - 4	LOW - 0	The UK's other abiotic factors are very similar to Central Europe.
1.17	How many species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism species are present in the Risk Assessment area? Specify the species or habitats and indicate the number.	very many - 4	LOW - 0	The raccoon is a generalist predator and no single species is "vital" for its survival, development and reproduction. Its diet changes in various locations in response to variation of food availability (Bartoszewicz et al. 2008). The raccoon inhabits a variety of habitats from wetland and forest to urban and suburban areas. Relevant prey/habitats are widespread in the Risk Assessment Area.
1.18	How widespread are the species (for herbivores, predators and parasites) or suitable habitats vital for the survival, development and multiplication of the organism in the Risk Assessment area?	widespread - 4	LOW - 0	Raccoons eat a wide range of both plant and animal matter and eat whatever is available. Their diet is composed of berries, nuts, seeds, insects, crayfish and crabs, fish, amphibians, turtles, birds (mainly waterfowl) and small mammals. In urban and suburban areas household rubbish can be a major food resource. Potential food sources are plentiful in the Risk Assessment Area.
1.19	If the organism requires another species for critical stages in its life cycle then how likely is the organism to become associated with such species in the risk assessment area?	N/A		
1.20	How likely is it that establishment will not be prevented by competition from existing species in the Risk Assessment area?	very likely - 4	LOW - 0	Although native carnivore species predate similar prey/food sources, observations from Central Europe and Japan suggest that the raccoon is unlikely to be out-competed (Hohmann 1999, Ikeda et al. 2004, Abe et al. 2006, Okabe and Agetsuma 2007). The high rate of raccoon expansion in Europe might confirm this suggestion. In its native range only larger predators like wolves and coyotes may prevent establishment by interference competition (Gehrt et al. 2003). There is a lack of such predators in the Risk Assessment Area.
1.21	How likely is it that establishment will not be prevented by natural enemies already present in the Risk Assessment area?	very likely - 4	LOW - 0	Lack of natural enemies in the Risk Assessment Area.
1.22	If there are differences in man's management of the environment/habitat in the Risk Assessment area from that in the area of present distribution, are they likely to aid establishment? (specify)	very unlikely - 0	LOW - 0	Man's management of the environment in the Risk Assessment Area is very similar to that in Central Europe and a large part of North America.
1.23	How likely is it that existing control or husbandry measures will fail to prevent establishment of the organism?	likely - 3	MEDIUM -1	High trapping pressure operates in a relatively small proportion of the Risk Assessment Area, thus it is unlikely to prevent raccoon population establishment, especially in suburban and farmland areas.
1.24	How often has the organism been recorded in protected conditions, e.g. glasshouses, elsewhere?	N/A		
1.25	How likely is the reproductive strategy of the organism and duration of its life cycle to aid establishment?	very likely - 4	LOW - 0	Reproduction strategy and life cycles similar to native Carnivora species.
1.26	How likely is it that the organism's capacity to spread will aid establishment?	likely - 3	MEDIUM -1	Maximal home range size is 60 km^2 and maximal natal dispersal up to 250 km (Bartoszewicz et al. 2008; Sutherland et al. 2000). The raccoon inhabits various types of habitats including wetland, forest, urban and suburban which suggests lack of dispersal barriers.
1.27	How adaptable is the organism?	very adaptable - 4	LOW - 0	The transcontinental original range of raccoon extends from southern Canada to Panama. Raccoons have been introduced, both deliberately and accidentally (escape from fur farms), in temperate Central Europe. This species has demonstrated great adaptability in respect of both climate and habitat.
1.28	How likely is it that low genetic diversity in the founder population of the organism will not prevent establishment?	very likely - 4	LOW - 0	In Germany, from a small number of individuals in 1930-40 the population increased to somewhere between 100,000 and one million raccoons.
1.29	How often has the organism entered and established in new areas outside its original range as a result of man's activities?	many - 3	LOW - 0	The raccoon was introduced for example in Germany (in 1934, successfully with high rate of expansion), Belarus (in 1936, successfully with low rate of expansion) , Caribbean islands (in 1932, successfully), Japan (in 1962, successfully). All introductions were the result of man's activities: the animals were originally imported for fur or as pets and were then either deliberately released or escaped.

1.30	How likely is it that the organism could survive eradication campaigns in the Risk Assessment area?	likely - 3	MEDIUM -1	Eradication is most likely to be achievable if control is undertaken while the population is small and in a restricted range. If the population is already established over a long-term and large area, then eradication is not considered to be feasible (Lutz 1996). Trapping is more successful than shooting (personal observation). There is a lack of detailed information about eradication programmes from Europe, but some actions have been undertaken in Japan (Kotani et al. 2009).
1.31	Even if permanent establishment of the organism is unlikely, how likely is it that transient populations will be maintained in the Risk Assessment area through natural migration or entry through man's activities (including intentional release into the outdoor environment)?	moderately likely - 2	MEDIUM -1	Import to collections open to the public and by private owners and release or escape of pets. Escapees can survive in the wild and establish new populations in the Risk Assessment Area. Small probability of unintentional transport.

	Spread	RESPONSE	UNCERTAINTY	COMMENT
2.1	How rapidly is the organism liable to spread in the Risk Assessment area by natural means?	rapid - 3	HIGH -2	In the first stage of invasion natural spread is limited. The raccoon was introduced successfully into Germany in 1934 and the German population was still in a relatively small area 20 years after introduction (Lutz 1984). Fifty years after successful introduction, the area of distribution extends beyond the borders of the Germany into the Netherlands, France, Switzerland, Austria, and Poland (Lutz 1984). In subsequent years, raccoon colonized Belgium, Luxemburg, Hungary, Czech Republic and former Yugoslavia (Mitchell-Jones et al. 1999, Červeny et al. 2001, Schley et al. 2001, Milenkovic 2003). Today, as many as 1 million raccoons are estimated to live in Germany, and their numbers are steadily increasing. In Japan, range expansion has been quite rapid after introduction (Hayama et al. 2006). Generally, once established, and with increased local density, the wild raccoon population has a high potential to rapidly spread due to long dispersal distance (max 250 km), high potential home range size, large reproductive potential (max litter size 8 young) and low mortality. In the face of invasion the chances of stopping it are low. For many years raccoon has been a game species in Germany, where its yearly hunting bag reaches over 20,000 individuals, however, hunting has no influence on the expansion of this invasive species to other countries.
2.2	How rapidly is the organism liable to spread in the Risk Assessment area by human assistance?	rapid - 3	MEDIUM -1	Human assistance increases spread by deliberate or incidental provision of food in urban and suburban areas (Ikeda et al. 2004, Bartoszewicz et al. 2008). Buildings serve the purpose of resting sites in severe winter conditions (Ikeda et al. 2004, Abe et al. 2006).
2.3	How difficult would it be to contain the organism within the Risk Assessment area?	easily - 1	MEDIUM -1	Preventing Raccoon from moving into new areas after it has established would be very difficult. Recent and rapid colonization of Germany and Poland suggest it might even be impossible.
2.4	Based on the answers to questions on the potential for establishment and spread define the area endangered by the organism.		LOW - 0	The whole Risk Assessment Area including various types of habitats: natural and anthropogenic habitats.

	Impacts	RESPONSE	UNCERTAINTY	COMMENT
2.5	How important is economic loss caused by the organism within its existing geographic range?	major - 3	LOW - 0	Raccoons can cause substantial damage. In urban areas, raccoons damage buildings (particularly attics and roofs), gardens, fruit trees, lawns, garbage cans and trash containers. In rural areas, raccoons may feed on farm crops, especially corn. In Europe, raccoon caused garden crop damage (e.g. fruit trees) (Hohmann et al. 2002). In the United States, raccoon damage to field corn has become a serious concern, especially in recent years – the annual economic losses caused by wildlife currently exceed $22 billion, with 25% of producers reporting raccoon damage to crops (Conover 1998, Beasley 2008). Despite the fact that is difficult to precisely estimate annual economic losses caused by raccoon, these losses are substantial. In Japan, the raccoon damages crops and fruits such as corn, melons, watermelons, strawberries, paddy rice, soybeans, potatoes, beets, oats and the total amount of agricultural damage amounts to 30 million yen every year (Ikeda et al. 2004). They also caused damage to roofs, attics and chimneys by, for example, destroying the insulation layer in the attic and thus limiting the effectiveness of the house insulation (Michler and Hohmann 2005). Economic losses caused by raccoon damage to houses would be of serious concern as their density could be high in cities (Michler and Hohmann 2005). The cost of damage is difficult to estimate but it may cost tens of thousands of dollars to fix one house (e.g. Craig Whitlock, From Nazi Past, a Proliferating Pest, The Washington Post, 26 May 2007, http://www.washingtonpost.com/wp-dyn/content/article/2007/05/25/AR2007052502272.html).
2.6	Considering the ecological conditions in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, livestock health and production, likely to be? (describe) in the Risk Assessment area, how serious is the direct negative economic effect of the organism, e.g. on crop yield and/or quality, likely to be?	moderate - 2	MEDIUM -1	Taking all above into account there is a high probability of serious direct negative economic effects of raccoon in the Risk Assessment Area.
2.7	How great a loss in producer profits is the organism likely to cause due to changes in production costs, yields, etc., in the Risk Assessment area?	moderate - 2	MEDIUM -1	See above
2.8	How great a reduction in consumer demand is the organism likely to cause in the Risk Assessment area?	minor - 1	MEDIUM -1	See above
2.9	How likely is the presence of the organism in the Risk Assessment area to cause losses in export markets?	moderately likely - 2	MEDIUM -1	See above
2.10	How important would other economic costs resulting from introduction be? (specify)	moderate - 2	MEDIUM -1	Large cost of eradication, control of numbers and monitoring (for example similar to coypu eradication or American mink control). The eradication of coypus for example cost £2.75 million in 1989 (Gosling 1989), whereas the campaign to control American mink cost approximately £552 000 (Baker 1990).
2.11	How important is environmental harm caused by the organism within its existing geographic range?	moderate - 2	MEDIUM -1	The raccoon is perceived as having a serious impact on birds in North America. It is a predator of eggs, chicks and adult birds, especially waterfowl (Hartman et al. 1999, Zeveloff 2002). Impact on bird populations may vary in relation to habitat (e.g. on coastal islands or in large seabird colonies) (Hartman et al. 1997, Hartman and Eastman 1999). For example, the presence of a few raccoons on islands in New England was sufficient to cause substantial breeding failure in large colonies of larids (Ellis et al. 2007). Possible impact on native competitors. In Japan, abundance of native raccoon dog decreased after invasion of raccoon (Ikeda et al. 2004). There is no evidence of raccoon impact on insects, fish, amphibians or reptiles in North America or Europe. Sea turtles might be an exception here, therefore raccoons are often removed from sea turtle nesting beaches to decrease egg mortality (e.g. Ratnaswamy et al. 1997, Ratnaswamy et al. 1998, Barton and Roth 2008). In an introduced range (Japan), a negative impact on native endangered prey species was suggested (Hayama et al. 2006). Possible impact on native competitors. In Japan, abundance of native raccoon dog decreased after invasion of raccoon (Ikeda et al. 2004). There are observations of raccoon predation on birds in Germany but without evidence of negative impact on native birds (Lutz 1981, Horstmann and Schmincke 2004). However, in an introduced range there are no studies of raccoon impact on waterfowl. This negative impact is highly probable.

2.12	How important is environmental harm likely to be in the Risk Assessment area?	moderate - 2	MEDIUM -1	Very likely to be - especially on inland birds and large seabird colonies. In some areas a small impact on rodent populations was described (Winchester et al. 2009), especially in areas where endangered rodent species survive in low density. Therefore, the impact on water vole in the Risk Assessment Area is possible, as both species occupy similar habitats. There is a rather small probability that raccoon will have an impact on insects, amphibians or reptiles in Europe as well as in the Risk Assessment Area.
2.13	How important is social and other harm caused by the organism within its existing geographic range?	moderate - 2	HIGH -2	The raccoon is one of the most chronic nuisance animal in North America, and can cause damage to fields, garden crops, and can damage or cause nuisance problems around houses.
2.14	How important is the social harm likely to be in the Risk Assessment area?	moderate - 2	HIGH -2	Very high risk to public health (parasites, see below) . Raccoons can cause damage to buildings, farms, gardens, etc.
2.15	How likely is it that genetic traits can be carried to native species, modifying their genetic nature and making their economic, environmental or social effects more serious?	very unlikely - 0	LOW - 0	There are not closely related species in the Risk Assesment area.
2.16	How probable is it that natural enemies, already present in the Risk Assessment area, will have no affect on populations of the organism if introduced?	very likely - 4	LOW - 0	In native range only a larger predator (wolves and coyotes) may prevent establishment by interference competition (Gehrt *et al.* 2003). There is a lack of such predators in the Risk Assessment Area.
2.17	How easily can the organism be controlled?	difficult - 3	LOW - 0	Control possible only in restricted areas at low raccoon density. At the invasion stage, control is very difficult (high probability of compensatory response to culling)(Kotani et al. 2009).
2.18	How likely are control measures to disrupt existing biological or integrated systems for control of other organisms?	unlikely - 1	LOW - 0	Selective trapping and shooting is likely.
2.19	How likely is the organism to act as food, a host, a symbiont or a vector for other damaging organisms?	very likely - 4	LOW - 0	Raccoons are known carriers of rabies, canine distemper, encephalitis, histoplasmosis, trypanosomiasis, coccidiosis, toxoplasmosis, tularemia, tuberculosis, listeriosis, leptospirosis, roundworms and mange (Zeveloff 2002). The most important is a roundworm *Baylisascaris procyonis* , the cause of severe human disease (Sorvillo 2002, Bartoszewicz et al. 2008). Furthermore, more than 90 species of wild and domestic animals have been identified as being infected with this roundworm which causes for example a fatal central nervous system disease in commercial chickens, pheasants and rabbits. Natural infections have been recognized in e.g. dogs, rodents, foxes and weasels. Children and pets are particularly at risk. This parasite was found in both native and introduced raccoon range (Sorvillo 2002, Bartoszewicz et al. 2008).
2.20	Highlight those parts of the endangered area where economic, environmental and social impacts are most likely to occur		HIGH -2	These parts of the Risk Assessment Area are primarily endangered: (i) Seabird colonies on islands and the mainland; waterfowl in some wetland areas; (ii) Urban and suburban areas (damage to houses, gardens etc.); (iii) Farms and crops (especially corn production); (iv) Human health in urban areas and farmland.

Summarise Entry	moderately likely - 2	MEDIUM -1	The spread of raccoon in Central Europe shows the high ability of the species to invade and colonize new areas. Small probability of unintentional transport but the increase in the number of captive breeding animals may contribute to the development of the wild population.
Summarise Establishment	likely - 3	MEDIUM -1	Abiotic and biotic conditions in the Risk Assessment Area are similar to Central Europe which suggests a high potential for establishing a population. High raccoon plasticity in habitat selection and food needs and the lack of enemies in the Risk Assessment Area increase the probability of successful establishment following entry.
Summarise Spread	intermediate - 2	MEDIUM -1	Once established, the raccoon has the high potential to spread throughout various habitats. Long distance dispersal, large home range and high reproductive plasticity (litter size from 1-8 young) make this species very invasive. However, the German population remained in a relatively small area over 20 years after introduction.
Summarise Impacts	major - 3	MEDIUM -1	The raccoon is a major predator of birds and rodents which might decrease biodiversity in local areas or under some circumstances it may cause drastic decrease of endangered/rare species. Raccoons can kill domesticated animals or transmit diseases and parasites to domestic and wildlife species and humans (children are particularly at risk). Furthermore, it can damage fields, gardens, crops and cause nuisance problems around houses. There is also a high probability of serious direct negative economic losses.
Conclusion of the risk assessment	MEDIUM -1	MEDIUM -1	Probability of entry is highest if the number of raccoons held privately as pets and in collections open to the public increases. In Japan, the population became established following a rapid increase in the popularity of the species as pets. It is apparent that the release and escape of raccoons from private owners has been the main source of raccoons found out of captivity in the UK over the past 40 years (Baker 1990, Harris and Yalden 2008). This source of animals needs to be clarified and include the escape / release of pets. The most important is to prevent deliberate introduction. On entry the species is likely to successfully establish a population in various habitats with the highest density in urban and suburban areas. Therefore, the most important potential impacts are human health, and damage to buildings or gardens. Potential environmental impact is connected with predation of local native prey. Eradication of an established population will be very problematic and costly.
Conclusions on Uncertainty		MEDIUM -1	The risk assessment is reliable. Raccoon is widely recognized as a pest animal, a predator that causes a decline in various prey species and a vector of disease and parasite transmission in its native and introduced range. Similar damage could occur in the Risk Assessment Area following the introduction and establishment of a racoon population. There are similar biotic and abiotic conditions in the Risk Assessment Area and in the introduced range in Central Europe. Higher level of uncertainty is related to pathways of entry. In 1984, raccoon was listed in a Schedule of the Dangerous Wild Animals Act 1976. A number of raccoons was then released and caused a decrease in the numbers of privately bred animals. Since a short time ago, raccoon is no longer covered by the Act, which could significantly increase its popularity as a pet and the possibility of a raccoon population becoming established in the Risk Assessment Area. The number of animals kept as pets should be registered.

References

Abe G, Ikeda T, and Tatsuzawa S (2006). Differences in habitat use of the native raccoon do (Nyctereutes procyonoides albus) and the invasive alien raccoon (Procyon lotor) in the Nopporo Natural Forest Park, Hokkaido, Japan. In: Assessment and control of Biological Invasion Risks, edited by F Koike, M. N. Clout, M Kawamich, M De Poorter, and K Iwatsuki, Shoukadoh Book Sellers Kyoto, Japan and IUCN, GLAND Switzerland, 116-121.

Baker S (1990) Escaped Exotic Mammals in Britain. Mammal Review 20, 75-96.

Barton BT, Roth JD (2008) Implications of intraguild predation for sea turtle nest protection. Biological Conservation 141, 2139-2145.

Bartoszewicz M, Okarma H, Zalewski A, Szczesna J (2008) Ecology of the raccoon (Procyon lotor) from western Poland. Annales Zoologici Fennici, 45, 291-298.

Beasley JC, Rhodes OE (2008) Relation between raccoon abundance and crop damage. Human-Wildlife Conflicts, 2, 248-259.

Červeny J, Anděra M, Koubek P, Homolka M, Toman A (2001) Recently expanding mammal species in the Czech republic: distribution, abundance and legal status. Beiträge zur Jagd- und Wildforschung 26, 111-125.

Conover MR (1998) Perception of American agricultural producers about wildlife on their farms and ranches . Wildlife Society Bulletin, 26, 597-604.

Conovery MR (1987) Reducing raccoon and birds damage to small corn plots. Wildlife Society Bulletin, 15, 268-272.

Corbert GB and Harris S (1996) The handbook of British Mammals. 3rd ed. Blackwell Science.

Elis JC, Shulman MJ, Jessop H, Suomala R, Morris SR, Seng V, Wagner M, Mach K (2007). Impact of raccoons on breeding success in large colonies of Great Black Gulls and Herring Gulls. Waterbirds, 30, 375-383.

Gehrt SD, Clark WR (2003) Raccoons, coyotes, and reflections on the mesopredator release hypothesis. Wildlife Society Bulletin, 31, 836-842.

Gosling LM (1989) Extinction to Order. New Scientist, 121, 44-49.

Greenwood AG, Cusdin PA, Radford M (2001) Effectiveness Study of the Dangerous Wild Animals Act 1976. Defra Research Contract CR0246.

Harris S and Yalden DW (2008) Mammals of the British Isles, Handbook 4th edition.

Hartman LH, Eastman DS (1999) Distribution of introduced raccoons Procyon lotor on the Queen Charlotte Islands: implications for burrow-nesting seabirds. Biological Conservation, 88, 1-13.

Hartman LH, Gaston AJ, Eastman DS (1997) Raccoon predation on ancient murrelets on East Limestone Island, British Columbia. Journal of Wildlife Management, 61, 377-388.

Hayama H, Kaneda M, and Tabata M (2006) Rapid range expansion of the feral raccoon (Procyon lotor) in Kanagawa Prefecture, Japan, and its impact on native organisms. In: Assessment and control of Biological Invasion Risk, edited by F Koike, M N Clout, M Kawamich, M De Poorter, and K Iwatsuki, Shoukadoh Book Sellers Kyoto, Japan and IUCN, GLAND Switzerland, p. 196-199.

Hohmann U (1999) Interspecific competition of the raccoon (Procyon lotor) and the wildcat (Felis silvestris slivestris) with regard to rest sites in Germany. Proceedings of XXIVth International Union of Game Biologists, Thessaloniki , 361-367.

Hohmann U, Voig S, Andreas U (2002) Raccoons take the offensive. A current assessment. In: Biologische Invasionen, edited by Kowarik I, Starfinger U, Neobiota1, 191-192.

Horwmann D, Schmincke B (2004) Beobachtungen zur Koexistenz von Mittelspecht und Waschbär. Natur und Heimat, 64(2), 55-60.

Ikeda T, Asano M, Matoba Y, Abe G (2004) Present status of invasive alien raccoon and its impact in Japan. Global Environmental Research, 8, 125-131.

Kotani K, Ishii H, Matsuda H, and Ikeda T (2009) Invasive species management in two-patch environments: agricultural damage control in the raccoon (Procyon lotor) problem, Hokkaido, Japan. Population Ecology 51,493-504.

Lutz W (1984) The distribution of the raccoon (Procyon lotor, Linne 1758) in Central Europe. Zeitschrift Fur Jagdwissenschaft, 30, 218-228.

Lutz W (1981) Untersuchungen zur Nahrungsbiologie des Waschbären Procyon lotor (Linne 1758) und zum Einfluß auf andere Wildarten in seinem Lebensraum. PhD dissertation University Heidelberg.

Lutz W (1984) The introduced raccoon Procyon lotor population in Germany. Wildl Biol 2,228.

Michler F-U, Hohmann U (2005) Investigations on the ethological adaptations of the raccoon (Procyon lotor L., 1758) in the urban habitat using the example of the city of Kassel, North Hessen (Germany), and the resulting conclusions for conflict management. In: Extended abstracts of the XXVIIth Congress of the International Union of Game Biologists, Hanover, 417-418.

Milenkovic DC (2003) The first record of the free-ranging raccoon (Procyon lotor Linnaeus, 1758) in Yugoslavia. Mamm. Biol. 68,116-117.

Mitchell-Jones AJ et al. (1999) The atlas of European mammals. T&A D Poyser Natural History.

Okabe F and Agetsuma N (2007) Habitat use by introduced raccoons and native raccoon dogs in a deciduous forest of Japan. J Mammal 88,1090-1097.

Parrott, D., Roy, S. and Fletcher, M. (2008) The status of scarce non-native birds and mammals in England. Report to Defra by CSL.

Ratnaswamy MJ, Warren RJ (1998) Removing raccoons to protect sea turtle nests: are there implications for ecosystem management? Wildlife Society Bulletin, 26, 846-850.

Ratnaswamy MJ, Warren RJ, Kramer MT, Adam MD (1997) Comparisons of lethal and nonlethal techniques to reduce raccoon depredation of sea turtle nests. The Journal of Wildlife Management, 61, 368-376.

Schley L et al. 2001. Neuburger und Heimkehre unte den Wildtieren Luxemburgs. Beitr Jagd-Wildforschung 26, 141-154.

Sorvillo F, Ash L, Berlin O et al. (2002) Basylisascaris procyonis: And emerging helminthic zoonosis. Emerging Infectious Diseases, 8, 355-359.

Sutherland G, Harestad AS, Price K, Lertzman K (2000) Scaling of natal dispersal distance in terrestrial birds and Mammals. Conservation Ecology, 4, 16 (http//www.consecol.org/vol14/iss1/art16).

Winchester Ch, Castlebery SB, Mengak MT (2009) Evaluation of factors restricting distribution of the endangered key largo woodrat. The Journal of Wildlife Management, 73, 374-379.

Zeveloff SI (2002) Raccoons a natural history. Smithsonian Institution Press. Washington and London.